ORIGINAL ARTICLE

A Comparative Study between Outcomes of Lateral Closed Wedge Osteotomy and Reverse V Osteotomy in Posttraumatic Cubitus Varus Deformity Patients at a Tertiary Care Center

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Abstract

Background: Cubitus varus deformity often requires surgical correction due to cosmetic and functional concerns. This study compares the outcomes of reverse V osteotomy and lateral closed wedge osteotomy for correcting posttraumatic cubitus varus in children.

Materials and methods: A prospective comparative study was conducted from June 2023 to May 2024 at Nil Ratan Sircar Medical College and Hospital, Kolkata, involving 30 children aged 8–15 years with posttraumatic cubitus varus. Subjects were evenly allocated to 2 cohorts, 15 in each, for the respective procedures. Outcomes were assessed based on clinical (range of motion and complications), radiological (cortical union and humerus–elbow–wrist angle), and functional (MEPS, LES, and Oppenheim grading) parameters. Information was processed using SPSS version 16, considering *p*-values below 0.05 as significant.

Results: At 6 months postsurgery, reverse V osteotomy demonstrated superior outcomes in range of motion (141.3 vs 133°, $p = 0.0001$), LES (51.47 vs 50.33, $p = 0.0098$), and Oppenheim grading (86.6% excellent vs 40% excellent). Humerus–elbow–wrist angle correction was comparable (18.33 vs 17.27°, $p = 0.18$), and cortical union reached 100% in both groups. Complications were minimal, with 1 infection per group managed conservatively.

Conclusion: Reverse V osteotomy offers better functional outcomes and range of motion compared to lateral closed wedge osteotomy, with comparable radiological correction and minimal complications. It is a reliable technique for correcting cubitus varus deformity in children, providing enhanced stability and cosmetic results.

Clinical significance: This study aims to identify a better method of cubitus varus deformity correction and compares its outcome with that of the most commonly used method, that is, lateral closed wedge osteotomy.

Keywords: Cubitus varus deformity, Deformity correction, Oppenheim score, Reverse V osteotomy.

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Introduction

Cubitus varus deformity, commonly referred to as "gunstock deformity," is a pathological condition characterized by a medial deviation of the forearm when the arm is fully extended, resulting in a reduced or negative carrying angle.[1]

Among pediatric fractures, upper limb injuries are reported to comprise approximately 65–75%, with supracondylar fractures of the humerus being the most prevalent type.[2] Cubitus varus misalignment ranks among the frequent aftermaths of supracondylar fracture due to malunion in children. It may be observed during the initial injury, after conservative treatment, or after operative treatment and as a late complication.[3]

Most patients usually achieve normal elbow function after fracture healing. The misalignment causes an unattractive appearance, with appearance being the main concern for guardians seeking rectification.[4]

Cubitus varus deformity is triplanar, consisting of sagittal, coronal, and rotational components. Numerous osteotomy methods have been suggested historically to tackle this issue. Many focus solely on inward tilt correction and are termed single-plane osteotomy. Dual-plane osteotomies address both sagittal and coronal errors. Three-plane osteotomies additionally handle rotational errors alongside sagittal and coronal plane errors.

Solfelt et al.[5] reported overall adverse event rates reached 14.5%, with unsatisfactory results at 12.7% across rectification methods. Persistent varus tilt was most prevalent at 5.9%, followed by nerve damage at 2.5%, infections at 2.5%, and repeat operations at 2.3%.

To date, no universal optimal method ensures maximal misalignment correction and cosmetic appearance that satisfies the patient and minimizes complications. An adapted reverse V-shaped bone cut incorporating computed medial translation of lower fragments was applied to correct varus tilt and sagittal plane issues while avoiding lateral condyle prominence.[6] This straightforward method ensures sufficient firmness with the offset cut and limited complications.

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The operation targeted restoring the elbow to match the unaffected side in structure and function. This study aims to compare the outcomes between lateral closed wedge osteotomy, the most commonly used technique, and reverse V osteotomy on the basis of clinical, radiological, and functional parameters.

Materials and Methods

Study Design

Prospective comparative study performed at the Orthopedics Department of Nil Ratan Sircar Medical College and Hospital, Kolkata, spanning June 2023 to May 2024.

Study Population

Children aged 8–15 years presenting with posttraumatic cubitus varus.

Sample Size

Thirty by total enumeration technique. Patients were divided into 2 groups, lateral closed wedge osteotomy and reverse V osteotomy, with 15 patients in each group.

Inclusion Criteria

Age 8–15 years, posttraumatic cubitus varus deformity.

Exclusion Criteria

Nontraumatic deformities, age <8 or >15 years, unwilling or unfit for surgery, active infection, or metal allergy.

Study Tools

X-rays (AP and lateral), clinical scores (MEPS and LES), and intraoperative templates.

Outcome Parameters

Clinical: ROM and complications.
Radiological: Cortical union and HEW angle.
Functional: MEPS, LES, and Oppenheim score.

Data Analysis

Data analyzed using SPSS version 16. *t*-tests or Wilcoxon tests for continuous data and Chi-squared tests for categorical data. Statistical significance threshold at $p < 0.05$.

Ethical Approval

Institutional Ethical Committee Nilratan Sircar Medical College & Hospital, Approval number: NRSMC/EC/243/2023 on 30 June 2023.

Surgical Technique

Reverse V Osteotomy

Clinical and radiological assessment: Skiagrams of both elbows in full extension and supination were obtained to measure the HEW angle bilaterally. The correction angle was calculated by adding the valgus angle of the unaffected side to the varus angle of the affected side (Fig. 1).

Template preparation: A true-size X-ray of the pathological elbow was taken in anteroposterior and lateral views for osteotomy planning. Point A was marked on the lateral supracondylar ridge, 5–10 mm above the olecranon fossa. A line was drawn perpendicular to the ridge, intersecting the medial supracondylar ridge at point B, forming the first bone cut (line AB). A second line was drawn from point B proximally at the calculated correction angle. A third line from point A intersected the second line at 90°, forming point C. The triangle ABC, with angle ABC as the correction angle and angle ACB at 90°, was cut from the paper outline to represent the bone to be resected (Fig. 2).

Surgical procedure: The patient was positioned in the lateral decubitus position with the elbow flexed. A posterior paratricipital approach to the distal humerus was followed.

The preprepared triangular template was placed 5–10 cm above the olecranon fossa on the distal humerus. The triangular area was resected using an oscillating saw. Point A was aligned to point C and temporarily secured with a K-wire, followed by permanent plate fixation (Figs 3 and 4).

Fig. 1: Measurement of HEW angle of bilateral side

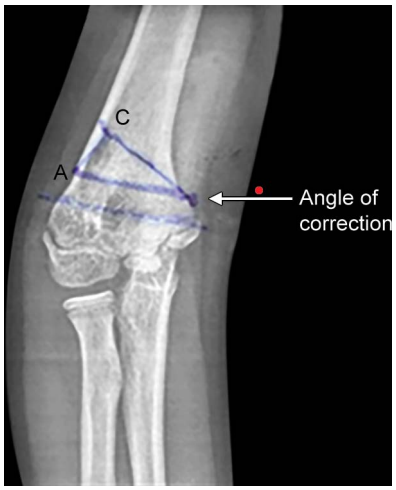

Fig. 2: Preparation of template on a true-size AP view skiagram

Lateral Closed Wedge Osteotomy

Preoperative Preparation

A skiagram of both upper limbs with elbows in full extension and supination was performed to measure the HEW angle. The correction angle was calculated as the normal valgus angle plus the varus angle of the unaffected side. A true-size X-ray of the pathological side was used to create a template for the osteotomy site.

Surgical Procedure

The patient was positioned supine with the arm to be operated on placed on a hand table.

A 4–6 cm incision was made on the elbow over the lateral supracondylar ridge. The deep fascia was incised, reflecting the brachioradialis anteriorly and the triceps posteriorly.

The site of osteotomy was marked on the humerus using the template to determine the lateral wedge length and angle. K-wires were placed proximally and distally, parallel to the site of the bone cut, and verified by C-arm. Two cortical screws were placed parallel to the K-wires, and the wedge of bone was resected.

The fragments were aligned by approximating the preplaced screws. Fixation was secured with loop wire in a figure-eight configuration around the screw tops after reduction, confirmed clinically with the opposite elbow in extension. Two K-wires were inserted from distal to proximal and lateral to medial for added stability (Fig. 5).

Fig. 3: Osteotomy done according to template

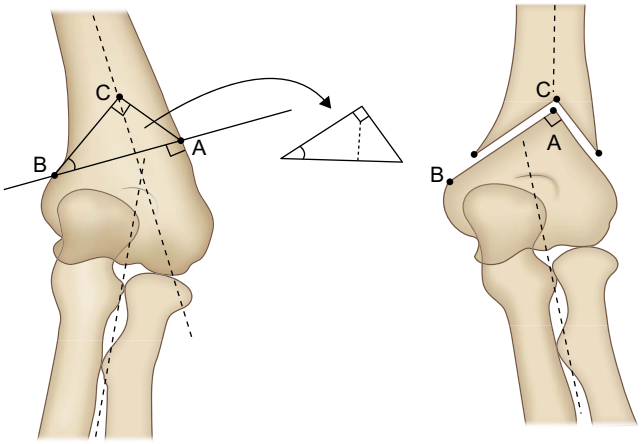

Fig. 4: Scheme of rotation of distal fragment over proximal fragment

The operated limb was immobilized in an above-elbow slab for 6 weeks, followed by slab removal and elbow mobilization.

Results

Demographics

Mean age was 10.8 years. Gender distribution was equal.

Preoperative Measures

Mean ROM: Reverse V 139.9°, lateral wedge 137.8°.
Mean HEW angle (varus): Reverse V 10.33°, lateral wedge 9.4°.
Mean MEPS: Reverse V 95.67, lateral wedge 96.68.
Mean LES: 47.8 in both groups.

Postoperative Outcomes

Mean Range of Motion

At 3 months: Reverse V 134.5°, lateral wedge 120.4° ($p = 0.0001$).
At 6 months: Reverse V 141.3°, lateral wedge 133° ($p = 0.0001$).

Mean HEW Angle Correction

At 6 months: Reverse V 18.33°, lateral wedge 17.27° ($p = 0.18$).

Cortical Union

At 3 months: Reverse V 73.3%, lateral wedge 80%.
At 6 months: 100% in both groups.

Functional Scores

Mean MEPS

At 3 months: Reverse V 98.3, lateral wedge 94 ($p = 0.0001$).
At 6 months: Reverse V 99.67, lateral wedge 99.33 ($p = 0.56$).

Mean LES

At 3 months: Reverse V 48.67, lateral wedge 47.2 ($p = 0.0063$).
At 6 months: Reverse V 51.47, lateral wedge 50.33 ($p = 0.0098$).

Oppenheim Grading at 6 Months

Reverse V: excellent 86.6%, good 13.4%.
Lateral wedge: excellent 40%, good 46.6%, poor 13.4%.

Complications

One infection in each group, both managed conservatively.

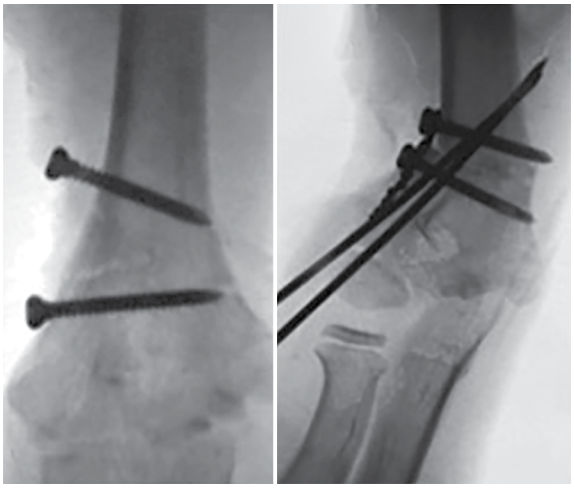

Fig. 5: Lateral closing wedge osteotomy and deformity correction

Discussion

Siris initially outlined a lateral closing wedge osteotomy for elbow varus correction in 1939.[7] Since then, diverse bone-cutting strategies have emerged. The dome osteotomy[8] has theoretically enabled rotational correction and medial translation while maintaining length. Lateral closing wedge osteotomy[9] is simple and secure but poses challenges such as difficulty in achieving firm internal fixation, delayed joint movement, and prominence of the lateral condyle or an S-shaped lazy curve due to inability to translate the cut fragment.

Step-cut osteotomy[10] relies on precise cutting and a distal segment wedge, with an intact periosteal hinge aiding control. This configuration offers some stability but carries the risk of narrow cortex fracture or screw penetration.

Yun et al. described reverse V osteotomy secured by crossed pins and side wiring for varus elbow treatment. As the osteotomy is performed slightly higher, it allows more distal segment bone for screw purchase in a plate. Its inherent stability stems from a snug wedge fit on both medial and lateral sides. Crossed pins with side wiring or plating further enhance fixation strength.[6]

In a study by Yun et al.,[6] reverse V osteotomy showed excellent results in 91% of cases and good results in 9% of cases, with transient ulnar nerve palsy observed in one case.

In a study by Oner et al.,[11] reverse V osteotomy with K-wire fixation showed excellent results in 78% of cases and good results in 22% of cases, with temporary radial nerve palsy in one case.

In a study by Srivastava et al.,[12] lateral closing wedge osteotomy showed excellent results in 86% of cases and good results in 14% of cases.

In a study by Bali et al.,[13] modified step-cut osteotomy with reconstruction plate fixation showed excellent results in 57% of cases, good results in 36% of cases, and poor results in 7% of cases, with residual varus deformity noted in 1 patient.

In a study by Moradi et al.,[14] spike translational osteotomy with lag screw or reconstruction plate fixation showed excellent results in 85% of cases and good results in 15% of cases.

In a study by Mishra et al.,[15] reverse V osteotomy with K-wire fixation and lateral wiring or Y-plate fixation showed excellent results in 90% of cases and good results in 10% of cases.

In the present study, at both 3 months and 6 months, patients who underwent reverse V osteotomy showed better ROM, with a statistically significant difference (p-value < 0.05). At 6 months follow-up, the mean correction of HEW angle for reverse V osteotomy was 18.33°, and for lateral closed wedge osteotomy it was 17.27°.

At 3 months follow-up, 73.3% cortical union was observed in the reverse V osteotomy group and 80% cortical union in the lateral closed wedge osteotomy group. At 6 months follow-up, cortical union was observed in 100% of cases in both groups.

At 3 months follow-up, MEPS in patients who underwent reverse V osteotomy showed better results, which were statistically significant (p-value < 0.05). At 6 months follow-up, both methods showed similar MEPS. At both 3 months and 6 months follow-up, LES in patients who underwent reverse V osteotomy showed better results, which were statistically significant (p-value < 0.05).

Two cases of surgical site infection occurred, one in each method. In both cases, the infection subsided within 2 weeks with administration of antibiotics according to culture sensitivity reports.

At 6 months follow-up, based on Oppenheim criteria, reverse V osteotomy showed excellent results in 86.6% of cases (13 patients) and good results in 13.4% of cases (2 patients). Lateral closed wedge osteotomy showed excellent results in 40% of cases (6 patients), good results in 46.6% of cases (7 patients), and poor results in 13.4% of cases (2 patients).

Conclusion

The study showed that at 6 months follow-up, based on Oppenheim criteria, reverse V osteotomy showed excellent results in 86.6% of cases (13 patients) and good results in 13.4% of cases (2 patients). Lateral closed wedge osteotomy showed excellent results in 40% of cases (6 patients), good results in 46.6% of cases (7 patients), and poor results in 13.4% of cases (2 patients).

Apart from this, in the case of reverse V osteotomy, early mobilization can be given, whereas in lateral closed wedge osteotomy, the elbow is immobilized in an above-elbow slab for 6 weeks. At 6 months, reverse V osteotomy demonstrated superior range of motion of the elbow joint and Liverpool Elbow Score, with statistical significance ($p < 0.05$).

Therefore, it can be concluded that the reverse V osteotomy technique is safe, consistent, repeatable, and straightforward for correcting elbow varus deformity.

Clinical Significance

The study shows that reverse V osteotomy yields better functional outcomes, greater range of motion, and comparable radiological correction to lateral closed wedge osteotomy, with minimal complications. This highlights its clinical superiority as a safer, more stable, and effective procedure for correcting posttraumatic cubitus varus deformity in children.

Study Limitations

The study population was relatively small.

The study was conducted in a tertiary care hospital, so hospital bias cannot be ruled out.

Author Contributions

All the authors equally contributed for the study.

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